A Novel Technique to Detect Epipelagic Fish Populations and Map Their Habitat

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LONG-TERM GOALS

The ultimate goal of this project is to substantially improve our understanding of the relation between ecologically important key fish species (e.g. sardine and albacore) and the physical environment by collecting synoptic measurements with improved spatial and temporal resolution of observations.

OBJECTIVES

Our partnership program is striving to develop a new method for detection of fish and synoptically mapping their environment at nested spatial and temporal scales. This new technique involves employing aerial data collection techniques (which are able to collect data at a much larger range of temporal and spatial scales than traditional methods) and coupling them with directed and coordinated ship-based observations, buoy data, and satellite-derived information. The nested array of observations are being analyzed and modeled in a GIS-based environment to provide qualitative and quantitative views of habitat- and behavioral- induced fish distribution patterns.

APPROACH

The overall objective of this work is to develop a new technique to detect epipelagic fishes and map their habitat and to test this technique in the EEZ of Oregon and Washington. The secondary objective is the analyze the array of spatial data collected to better understand the connection and affects of habitat and fish behavior on fish detection and distribution. The technique combines data from satellites, aircraft, ships, and moorings. Each platform covers a unique set of spatial and temporal scales, and each instrument has its own advantages and disadvantages. A technique combining data from multiple platforms can be much more powerful than any one alone.

Field work for this project was completed in June, 2006, and we are beginning synthesis and processing of year 1 and year 2 data. In the coming year we will coordinate efforts with collaborators to combine satellite data, airborne LIDAR and radiometer data, shipborne fish and plankton sampling data, shipborne acoustic echosounder data, and acoustic mooring data using a GIS-based technique for spatial and temporal relationships.

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WORK COMPELETED

Four acoustic bouy moorings were deployed northwest of the mouth of the Columbia River in the second year of fieldwork. These moorings were deployed and recovered from the *F/V Frosti* from June 2 –7, 2006 during simultaneous ship-board acoustic surveys, plankton, and fish sampling. Moorings were deployed in a 1 by 1 nautical mile box pattern within the Columbia River plume. The site selected was in the same general region as two acoustic moorings deployed during the previous year of fieldwork, and was a region believed to have the highest potential for frequent fish targets based off pre-cruise LIDAR and spotter pilot flight reports.

Figure 1. A strong frontal boundary indicating the Columbia River Plume visible from the F/V Frosti near the mooring box site.

Shipborne acoustic echosounder surveys were conducted over the mooring box during daytime, nighttime, dawn, and dusk in order to resolve the diel patterns of fish and plankton behavior. These surveys will serve as a comparison with the acoustic moorings to integrate data collected over different time and spatial scales.

In addition to ship-borne acoustic surveying, a CTD and Tracor acoustical profiling system (TAPS) were used to simultaneously sample hydrographic conditions and acoustically profile zooplankton distribution. A total of 10 CTD/TAPS profiles were conducted during the ship-board plankton and fish sampling. These data will supplement 16 plankton collections by Bongo nets and 8 fish trawls.

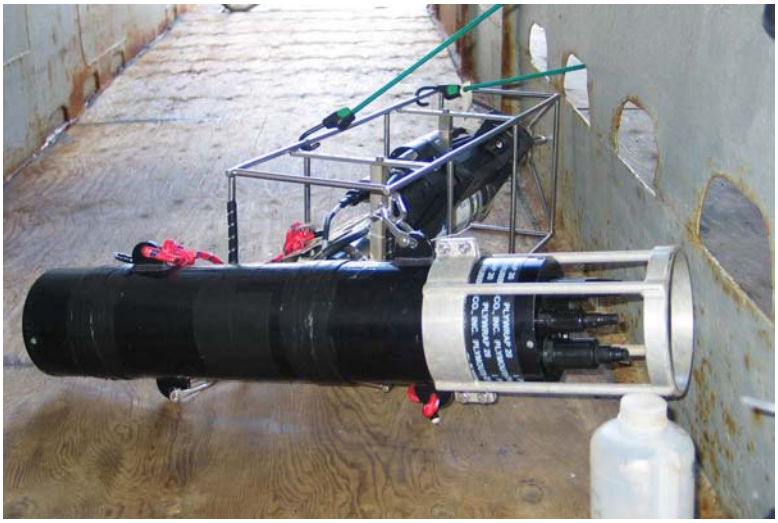

Figure 2. The Tracor acoust profiling system (TAPS) attached to a CTD used to profile water hydrography and plankton distribution.

RESULTS

Preliminary moored acoustic and LIDAR data analysis from the first field season have shown that the dominant signal was a strong diel pattern in both.

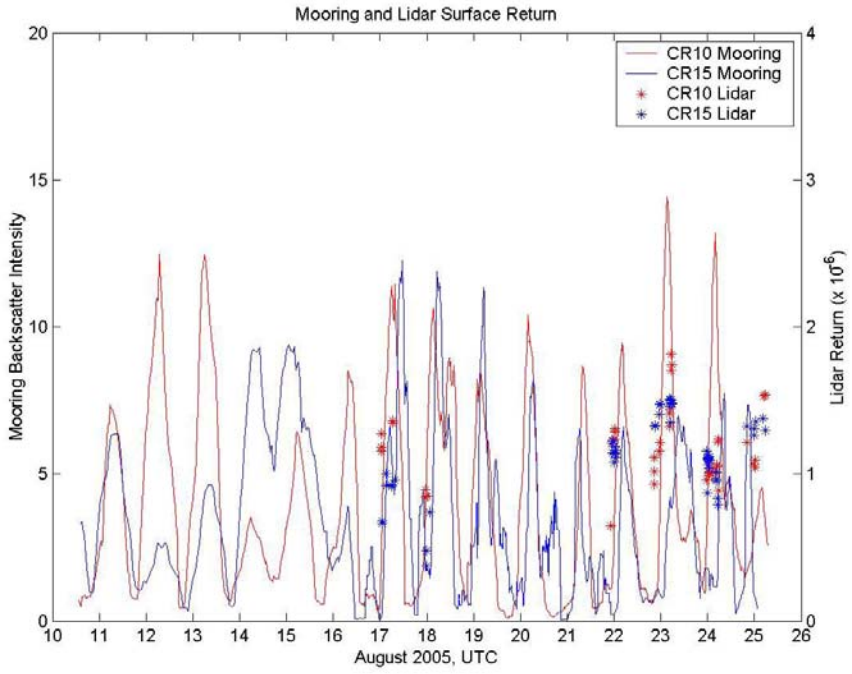

Figure 3. Preliminary comparison of acoustic and LIDAR data showing a strong diel pattern present in both.

This year, four acoustic moorings were deployed in a box pattern from 115 to 130 meters water depth that recorded acoustic backscatter every 12 seconds during the study period. Ship-borne towed

acoustics and air-borne LIDAR surveyed over the mooring box, overlapping spatial and temporal data collection.

Surface fish trawl samples collected during ship-board surveys indicated a difference in the biology of this June cruise compared to last years August sampling cruise in the same region. Fewer bait fish (sardine and anchovies) were present but many more juvenile salmon were caught which may reflect a difference in the timing of the study.

Figure 4. Fish trawl samples caught during ship-borne fish surveying over mooring sites dominated by juvenile salmon.

IMPACT/APPLICATIONS

This project will:

1. Refine Fish LIDAR data processing techniques and test the results by a comparison with echo sounder, airborne video, trawl, and quantified aerial survey visual observation data. Particular attention will be paid to taxa identification in aerial surveys using LIDAR depolarization, school morphology, and habitat clues.

2. Develop a technique to combine LIDAR, echo sounder, and sampling data to produce a species-specific measure of fish distribution. The first step will be to develop a technique to combine the data into a consistent index of abundance. We will then try to develop an accurate number density estimate.

3. Develop a technique to design the most accurate fish survey for a fixed cost. This will use adaptive sampling strategies where a low-cost LIDAR survey directs an echo sounder survey to the most productive regions within the habitat. The echo sounder survey, in turn, is used to design trawl placement to get the maximum amount of information.

4. Develop GIS-based techniques to quantitatively relate the distribution of epipelagic fishes to their habitat.

RELATED PROJECTS

The comparison of lidar and acoustic sampling techniques for assessing biology in this work is strongly related to the collaboration between Benoit-Bird and Concannon and Prentice (NAVAIR). Concannon and Prentice are funded through ONR under the LOCO DRI and Benoit-Bird through the YIP program. This project seeks to compare airborne lidar and ship and moored acoustics, focusing primarily on fish as targets while the LOCO project compares ship based lidar with ship and moored acoustics primarily focusing on plankton as targets.